WORKSHOP SUMMARY

from

A PLANNING MEETING FOR WATER QUALITY MONITORING
Pacific Island I&M Network
National Park Service

Guam
War In The Pacific National Historical Park (WAPA)
Commonwealth of the Northern Mariana Islands
American Memorial Park (AMME)
American Samoa
National Park of American Samoa (NPSA)
Hawaii
U S S Arizona Memorial (USAR)
Kalaupapa National Historical Park (KALA)
Haleakala National Park (HALE)
Ala Kahakai National Historic Trail (ALKA)
Pu`ukohola Heiau National Historic Site (PUHE)
Kaloko-Honokohau National Historical Park (KAHO)
Pu`uhonua o Honaunau National Historical Park (PUHO)
Hawaii Volcanoes National Park (HAVO)

August 12-13, 2003
Kailua-Kona, Hawaii

Eva DiDonato, Water Quality Workgroup Lead
Kimber Deverse, Workgroup Facilitator

Fritz Klasner, Network Ecologist
Darcy Hu, Network Science Advisor
Gordon Dicus, Network Data Manager

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CONTRIBUTORS TO THE MEETING

Kailua-Kona, Hawaii

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NON-GOVERNMENT ORGANIZATIONS

Sara Peck – University of Hawaii Sea Grant Extension Agent, West Hawaii

INTRODUCTION AND PURPOSE

The Water Quality Workgroup for the Pacific Island Network (PACN) started in August, 2002. The Workgroup was tasked with developing a water quality monitoring program for the PACN. Although this program is primarily funded through NPS Water Resources Division (WRD), it is to be developed along side the NPS National Inventory and Monitoring Program. Several NPS documents are being used to guide our process (see: http://science.nature.nps.gov/im/monitor/protocols/wqPartB.doc, and http://science.nature.nps.gov/im/monitor/vsmTG.htm). We are currently transitioning from Phase 1 to Phase 2 of the process. We have hired a workgroup research assistant who will continue to collect and summarize background data for each of the parks in the PACN, and fill in other current gaps.

In August, 2003 we had a planning meeting for water quality monitoring in the PACN. The purpose of the meeting was to work towards the completion of required sections in our Monitoring Plan report (Phase 1 & beyond), and begin planning fundamental aspects of the program with the help of NPS staff and potential partners. From this meeting, several outcomes were expected:

- An understanding of NPS-WRD, the Pacific Island Network, and the accomplishments & direction of the Water Quality Workgroup.
- An updated Phase 1 report made possible by technical and professional advice from participants.
- An understanding of EMAP and how it can benefit our program.
- Preliminary planning for our program.
- Partnerships.
- Meeting report (this document).

The meeting started with introductory presentations in order to make everyone familiar with the structure of the program we are working under. Presentations were given by Roy Irwin (National/Regional Perspective: http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/roy_pacnqapp7.pps), Fritz Klasner (Network Perspective: http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/fritz_wq-mtg20030812.pps), and Eva DiDonato (Water Quality Workgroup Perspective: http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/eva_planningmeeting.pps). Copies of these presentations are linked to this document. Following these presentations, there were several group discussions. Information from these discussions provides a foundation from which we can develop our monitoring program. The topics of these discussions included:

- Problem Statement/Values to be Protected
- Monitoring Objectives/Monitoring Questions
- Desired Future Conditions
- Preliminary Study Design
- Water Quality Monitoring Boundaries for each Park

This report summarizes the outcomes of those discussions, all of which are key elements to be incorporated into our Phase 1 report. In the process, we are setting the stage for the next phase of our work. This document is meant to be a stepping stone in the development of the PACN water quality monitoring program. Please direct any questions or comments to Eva DiDonato (eva_didonato@nps.gov), and Fritz Klasner (fritz_klasner@nps.gov).

Existing Water Quality Monitoring Summary

This topic was not specifically covered during the meeting. However, it is important in the context of developing a monitoring program to keep in mind the current management issues and programs in our network parks. It is therefore presented below.

Review of Park-Specific Management Issues

Each of the park units in PACN is unique in their location and in stressors that affect their water resources. PACN parks have near shore reef communities that may be impacted by situations inside or outside of park boundaries. In general, most of the parks do not have jurisdiction over the reef areas they are mandated to protect. Marine waters are impacted by chemical pollution and sewage discharges from commercial ships and harbor operations. Recreational activities such as fishing, camping, boating, and swimming are commonly adjacent to reef areas. In addition, management of areas inland of park boundaries affects the marine environment. Almost all parks are susceptible to the effects of feral animals that degrade vegetation and accelerate erosion. Development of adjacent lands and watersheds is a concern at all parks. Runoff from agricultural and urban development and sedimentation due to natural and man-made causes contribute to eutrophication, bacterial and chemical contamination, and increased turbidity. Human population growth contributes to loss of habitat buffers and subsequent degradation of water quality. The rising sea level, due to global warming, will contribute to shoreline erosion and sedimentation of the reef. In addition, coral bleaching, mortality and disease are occurring due to warming sea surface temperatures.

Through surveys and other communications, each park has identified the stressors which are most threatening to their water resources. These stressors are identified here on a park-by-park basis omitting the overall reef concerns covered above.

- **WAPA**: Sedimentation of the reefs in Guam is aggravated by fires that consume the vegetation upslope. There is a power plant down current of the parks with a submerged thermal discharge pipe. PCBs are leaching from the military installation on the Orote Peninsula adjacent to the Agat unit. The Asan unit has wetlands which are susceptible to contamination from unsewered residential areas and flooding events which bring soil and agricultural runoff. Inland units are unexplored and/or inaccessible making characterization of water bodies difficult there.
- **AMME**: Additional reef concerns include seepage and runoff from a garbage dump up-current and a site where PCBs were "cleaned up." This is compounded by the barrier reef which constricts water flow into and out of the marine area. Wetlands are present in the inland corner of the park where encroaching development, illegal dumping (past and present), flooding, and groundwater contamination from sewage are major concerns.
- **NPSA**: Due to the traditional communal land tenure in American Samoa, the park area is leased from surrounding villages. Subsistence use of the land and water resources is allowed contributing to erosion from agricultural use and contamination from sewage. In a few instances, the upper portion of a stream will be within NPSA boundaries, while the lower part flows through a village before entering the sea. Impacted stream water reaching the reef may inhibit natural stream fauna from repopulating streams after a juvenile marine stage. Streams are also degraded by feral pigs. Tide pools located at the shoreline are impacted by visitor use and climate change. In the Ofu unit of NPSA there is a closed dump site that continues to percolate water of unknown quality into the marine environment. There are temperature tolerant corals near the west end of this unit which are an especially valuable resource. The location and possible extension of a landing strip in this area is of great concern. Offshore of the Ta'u unit, there are giant, single coral heads of significant age which are invaluable to studies of climate and marine ecology.
- **USAR**: This park is located in Pearl Harbor where industrial and agricultural pollution are long-standing issues which have contributed to the degradation of this estuary. The centerpiece of this park is a sunken ship which has remained relatively undisturbed in spite of the release of petroleum products from within the hull as it rusts away. The ship also contributes to the presence of heavy metals dissolved in the water column and deposited in the sediment.
- **KALA**: Feral pigs, deer and cattle degrade stream resources in and around this park. This adds to the stresses caused by diversion and input due to agriculture and urban development. Village areas in the park may have issues with the leaching of untreated sewage and PCBs. There is a large, deep, water-filled crater unique to this park.

- **HALE:** There are numerous freshwater streams in this park which also has coastal springs and a sub-alpine lake unique in this network. Although it has a relatively small coastal shoreline, it has a very large watershed in which the streams and lake are threatened by encroaching development, feral animals, and alien species. Fishing and swimming are common in streams which enter the ocean. Stream diversion may be an issue as watershed partnerships affect management of this area.
- **ALKA**: As a National Historic Trail, the resources of this park are extensive and encounter every type of water quality issue addressed by this work group. This park has just been established and is still in the planning stages. There are numerous problem areas which include those outlined below for PUHE, KAHO, PUHO, and HAVO. At this point, the major concerns of the park planners are for human health conditions at beaches and fish ponds which have high visitor use. They are also concerned about water quality being affected by increasing traffic as the park develops.
- **PUHE**: A recreational harbor exists adjacent to the park and a commercial shipping facility on the other side of that. These contribute to the likelihood that marine recreation activities such as fishing and diving will contribute to fuel spills, pollution, and alteration of the substrate. Dirt biking along coral flats and stream beds, municipal and industrial wastewater discharges, residential and resort development, and land-based recreational activities all contribute to erosion and pollution of the near shore water. A stream originating upslope from the park is affected by diversion, storm water runoff, and eroding top soil.
- **KAHO**: There are numerous anchialine pools, two fish ponds, and a large embayment in this park located down slope of a growing industrial area. Leaching from upslope cesspools, septic tanks, and industrial development contributes to bacterial contamination and nutrient loading of these resources. A small boat harbor is located between park units and is a source of petroleum, heavy metals, and phosphates from wash water. The threat of sedimentation onto the coral reef is increased by pond restoration activities, erosion of the sandy shoreline, and dredging and/or expansion of the harbor.
- **PUHO**: Urban development up-slope from the park and the high level of tourism will negatively impact the water quality of anchialine pools, fishponds, and the near shore marine environment. The anchialine pools are vulnerable to invasives, sedimentation and eutrophication. There is a submerged, natural discharge through a lava tube which is unique to this park and could be a conduit for contaminants originating upslope.
- **HAVO:** There are intermittent streams located in this park which is primarily made up of relatively fresh volcanic flows. Although the coastal area is large, the man-made stressors are limited by the volcanic activity which is the main agent of change there. There are anchialine pools along the coastal section and wetlands or bogs in the forested Ola’a unit which have not been assessed.

Current Water Quality Programs at Pacific Island Network Parks

Various water quality studies are in progress or are being planned to assess conditions at or near PACN parks. Few of these programs involve long term monitoring plans. Most study areas are outside of park boundaries and may have only one sampling location. Table 1 indicates the activity stage for current or planned projects and the issues addressed, or not addressed, for each parks resources. An **X** in the “unaddressed” column indicates that no work is on-going or planned concerning that particular resource and the associated stressor. Programs in the planning or implementation stages are marked under the “in prep” column for the appropriate resource and issue to be addressed. The “short-term” category indicates projects geared to data gathering for one-time studies of specific issues. Two types of markers are used in the “long-term” column to differentiate between comprehensive monitoring (**C**) of a park resource and limited studies (**X**) which do not fulfill the expectations for this program either in scope or study area.

Table 1. This table indicates the status of current water quality monitoring for each parks resources and their associated stressors. "Long term" programs are marked with a **C** if they are comprehensive and complement our resource monitoring goals for the park, while an **X** indicates that it is limited in scope or sampling location. "Short term" projects have a set completion date and generally focus on a specific resource or issue. Some projects are considered "suspended" due to lack of funding although they may have been collecting important data for some time. "In prep" describes studies that are pending or being implemented at this time. Most resource stressors are "unaddressed" in regards to water quality monitoring as shown below.

PARK	RESOURCE	STRESSOR(S)	ACTIVITY STAGE				
			long-term	short-term	in-prep	suspended	unaddressed
WAPA	Streams	Climate Change				X	
		Erosion				X	
		Hydrology		X			
		Invasives					X
		Microbial Contamination				X	
		Organic Enrichment		X		X	
		Sedimentation		X			
		Toxics		X		X	
	Groundwater	Hydrology		X	X		
		Microbial Contaminants					X
		Organic Enrichment					X
		Toxics		X			
	Wetlands	Atmosheric Deposition					X
		Climate Change		X			
		Erosion		X			
		Hydrology		X			
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment		X			
		Sedimentation		X			
		Toxics		X			
	Beaches	Climate Change					X
		Erosion					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants	X				
		Organic Enrichment					X
		Toxics					X
	Nearshore/coastal	Climate Change		X	X		
		Hydrology		X			
		Invasives			X		
		Microbial Contaminants					X
		Organic Enrichment			X		
		Sedimentation	C		X		
		Toxics		X	X		

PARK	RESOURCE	STRESSOR(S)	ACTIVITY STAGE				
			long-term	short-term	in-prep	suspended	unaddressed
AMME	Streams	Climate Change					X
		Erosion		X			
		Hydrology		X	X		
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment		X			
		Sedimentation					X
		Toxics		X			
	Groundwater	Hydrology		X	X		
		Microbial Contaminants					X
		Organic Enrichment		X			
		Toxics		X			
	Wetlands	Atmosheric Deposition					X
		Climate Change					X
		Erosion					X
		Hydrology		X	X		
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Sedimentation					X
		Toxics		X			
	Beaches	Climate Change					X
		Erosion					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants	C				
		Organic Enrichment	C				
		Toxics					X
	Nearshore/coastal	Climate Change	C				
		Hydrology					X
		Invasives					X
		Microbial Contaminants	C				
		Organic Enrichment	C				
		Sedimentation	C				
		Toxics			X		

PARK	RESOURCE	STRESSOR(S)	ACTIVITY STAGE				
			long-term	short-term	in-prep	suspended	unaddressed
NPSA	Streams	Climate Change		X			
		Erosion					X
		Hydrology		X	X		
		Invasives					X
		Microbial Contaminants		X	X		
		Organic Enrichment		X	X		
		Sedimentation					X
		Toxics			X		
	Groundwater	Hydrology				X	
		Micobial Contaminants					X
		Organic Enrichment					X
		Toxics					X
	Beaches	Climate Change					X
		Erosion					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Toxics					X
	Nearshore/coastal	Climate Change	X	X			
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment		X			
		Sedimentation					X
		Toxics					X
	Tide Pools	Climate Change					X
		Micobial Contaminants					X
		Organic Enrichment					X

PARK	RESOURCE	STRESSOR(S)	ACTIVITY STAGE				
			long-term	short-term	in-prep	suspended	unaddressed
USAR	Streams	Climate Change					**X**
		Erosion					**X**
		Hydrology				**X**	
		Invasives					**X**
		Microbial Contaminants				**X**	
		Organic Enrichment				**X**	
		Sedimentation					**X**
		Toxics				**X**	
	Groundwater	Hydrology				**X**	
		Micobial Contaminants				**X**	
		Organic Enrichment				**X**	
		Toxics				**X**	
	Beaches	Climate Change					**X**
		Erosion					**X**
		Hydrology					**X**
		Invasives					**X**
		Microbial Contaminants					**X**
		Organic Enrichment					**X**
		Toxics					**X**
	Nearshore/coastal	Climate Change					**X**
		Hydrology		**X**			
		Invasives					**X**
		Microbial Contaminants					**X**
		Organic Enrichment	**C**	**X**			
		Sedimentation		**X**			
		Sedimentation	**C**				
		Toxics	**C**	**X**			

PARK	RESOURCE	STRESSOR(S)	ACTIVITY STAGE				
			long-term	short-term	in-prep	suspended	unaddressed
KALA	Streams	Climate Change					**X**
		Erosion					**X**
		Hydrology				**X**	
		Invasives					**X**
		Microbial Contaminants					**X**
		Organic Enrichment					**X**
		Sedimentation					**X**
		Toxics					**X**
	Groundwater	Hydrology				**X**	
		Microbial Contaminants				**X**	
		Organic Enrichment				**X**	
		Toxics				**X**	
	Beaches	Climate Change					**X**
		Erosion					**X**
		Hydrology					**X**
		Invasives					**X**
		Microbial Contaminants					**X**
		Organic Enrichment					**X**
		Toxics					**X**
	Nearshore/coastal	Climate Change					**X**
		Hydrology					**X**
		Invasives					**X**
		Microbial Contaminants					**X**
		Organic Enrichment					**X**
		Sedimentation					**X**
		Toxics					**X**
	Kahakau Crater	Organic Enrichment					**X**
		Toxics					**X**
		Hydrology					**X**

PARK	RESOURCE	STRESSOR(S)	ACTIVITY STAGE				
			long-term	short-term	in-prep	suspended	unaddressed
HALE	Sub-alpine Lakes	Atmospheric Deposition					X
		Climate Change					X
		Erosion					X
		Hydrology					X
		Invasives					X
		Organic Enrichment					X
		Sedimentation					X
		Toxics					X
	Streams	Climate Change					X
		Erosion					X
		Hydrology				X	
		Invasives					X
		Microbial Contaminants				X	
		Organic Enrichment				X	
		Sedimentation					X
		Toxics					X
	Groundwater	Hydrology				X	
		Micobial Contaminants				X	
		Organic Enrichment				X	
		Toxics				X	
	Anchialine Pools	Atmosheric Deposition					X
		Climate Change					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Sedimentation					X
		Toxics					X
	Beaches	Climate Change					X
		Erosion					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Toxics					X
	Nearshore/coastal	Climate Change					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Sedimentation					X
		Toxics					X
	Coastal Springs	Hydrology					X
		Organic Enrichment				X	
		Toxics					X
		Microbial Contaminants				X	

PARK	RESOURCE	STRESSOR(S)	ACTIVITY STAGE				
			long-term	short-term	in-prep	suspended	unaddressed
ALKA	Streams	Climate Change					X
		Erosion	X				
		Hydrology	X			X	
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Sedimentation	X				
		Toxics					X
	Groundwater	Hydrology			X	X	
		Microbial Contamination	X			X	
		Organic Enrichment	X		X	X	
		Toxics				X	
	Anchialine Pools	Atmosheric Deposition					X
		Climate Change					X
		Hydrology	X		X		
		Microbial Contamination	X				
		Organic Enrichment	X		X		
		Sedimentation					X
		Toxics					X
	Fish Ponds	Atmosheric Deposition					X
		Climate Change					X
		Erosion					X
		Hydrology			X		
		Invasives			X		
		Microbial Contamination		X			
		Organic Enrichment		X	X		
		Sedimentation			X		
		Toxics					X
	Wetlands	Atmosheric Deposition					X
		Climate Change					X
		Erosion					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Sedimentation					X
		Toxics					X
	Beaches	Climate Change					X
		Erosion					X
		Hydrology					X
		Invasives					X
		Microbial Contamination	X				
		Organic Enrichment	X				
		Toxics					X
	Nearshore/coastal	Climate Change					X
		Hydrology			X		
		Invasives					X
		Microbial Contamination	X	X			
		Organic Enrichment	X	X			
		Sedimentation			X		
		Toxics					X

PARK	RESOURCE	STRESSOR(S)	ACTIVITY STAGE				
			long-term	short-term	in-prep	suspended	unaddressed
PUHE	Streams	Climate Change					**X**
		Erosion	**C**				
		Hydrology	**C**			**X**	
		Invasives					**X**
		Microbial Contaminants				**X**	
		Organic Enrichment					**X**
		Sedimentation	**C**				
		Toxics				**X**	
	Groundwater	Hydrology				**X**	
		Micobial Contaminants				**X**	
		Organic Enrichment				**X**	
		Toxics				**X**	
	Fish Ponds	Atmosheric Deposition					**X**
		Climate Change					**X**
		Erosion					**X**
		Hydrology					**X**
		Invasives					**X**
		Microbial Contamination		**X**			
		Organic Enrichment		**X**			
		Sedimentation					**X**
		Toxics					**X**
	Beaches	Climate Change					**X**
		Erosion					**X**
		Hydrology					**X**
		Invasives					**X**
		Microbial Contamination	**X**				
		Organic Enrichment	**X**				
		Toxics					**X**
	Nearshore/coastal	Climate Change					**X**
		Hydrology			**X**		
		Invasives					**X**
		Microbial Contamination		**X**			
		Organic Enrichment		**X**			
		Sedimentation			**X**		
		Toxics					**X**

PARK	**RESOURCE**	**STRESSOR(S)**	**ACTIVITY STAGE**				
			long-term	**short-term**	**in-prep**	**suspended**	**unaddressed**
KAHO	Groundwater	Hydrology				**X**	
		Hydrology			**X**		
		Microbial Contamination	**X**			**X**	
		Organic Enrichment	**X**		**X**	**X**	
		Toxics				**X**	
	Anchialine Pools	Atmospheric Deposition					
		Climate Change					**X**
		Hydrology			**X**		
		Invasives					**X**
		Microbial Contamination	**X**				
		Organic Enrichment	**X**		**X**		
		Sedimentation					**X**
		Toxics					**X**
	Fish Ponds	Atmosheric Deposition					**X**
		Climate Change					**X**
		Erosion					**X**
		Hydrology			**X**		
		Invasives			**X**		
		Microbial Contaminants					**X**
		Organic Enrichment			**X**		
		Sedimentation			**X**		
		Toxics					**X**
	Wetlands	Atmosheric Deposition					**X**
		Climate Change					**X**
		Erosion					**X**
		Hydrology					**X**
		Invasives					**X**
		Microbial Contaminants					**X**
		Organic Enrichment					**X**
		Sedimentation					**X**
		Toxics					**X**
	Beaches	Climate Change					**X**
		Erosion					**X**
		Hydrology					**X**
		Invasives					**X**
		Microbial Contamination	**X**				
		Organic Enrichment	**X**				
		Toxics					**X**
	Nearshore/coastal	Climate Change					**X**
		Hydrology					**X**
		Invasives					**X**
		Microbial Contamination	**X**				
		Organic Enrichment	**X**				
		Sedimentation					**X**
		Toxics					**X**

PARK	RESOURCE	STRESSOR(S)	ACTIVITY STAGE				
			long-term	short-term	in-prep	suspended	unaddressed
PUHO	Streams	Climate Change					X
		Erosion					X
		Hydrology				X	
		Invasives					X
		Microbial Contamination				X	
		Organic Enrichment				X	
		Sedimentation					X
		Toxics				X	
	Groundwater	Hydrology				X	
		Micobial Contaminants				X	
		Organic Enrichment				X	
		Toxics				X	
	Anchialine Pools	Atmosheric Deposition					X
		Climate Change					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Sedimentation					X
		Toxics					X
	Fish Ponds	Atmosheric Deposition					X
		Climate Change					X
		Erosion					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Sedimentation					X
		Toxics					X
	Beaches	Climate Change					X
		Erosion					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Toxics					X
	Nearshore/coastal	Climate Change					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Sedimentation					X
		Toxics					X
	Submerged Spring	Hydrology					X
		Microbial Contamination					X
		Organic Enrichment					X
		Toxics					X
		Sedimentation					X

PARK	RESOURCE	STRESSOR(S)	ACTIVITY STAGE				
			long-term	short-term	in-prep	suspended	unaddressed
HAVO	Streams	Climate Change					X
		Erosion					X
		Hydrology				X	
		Invasives					X
		Microbial Contamination				X	
		Organic Enrichment				X	
		Sedimentation					X
		Toxics				X	
	Groundwater	Hydrology				X	
		Micobial Contaminants				X	
		Organic Enrichment				X	
		Toxics				X	
	Anchialine Pools	Atmosheric Deposition					X
		Climate Change			X		
		Hydrology			X		
		Invasives			X		
		Microbial Contaminants					X
		Organic Enrichment			X		
		Sedimentation					X
		Toxics					X
	Wetlands	Atmosheric Deposition					X
		Climate Change					X
		Erosion					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Sedimentation					X
		Toxics					X
	Beaches	Climate Change					X
		Erosion					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Toxics					X
	Nearshore/coastal	Climate Change					X
		Hydrology					X
		Invasives					X
		Microbial Contaminants					X
		Organic Enrichment					X
		Sedimentation					X
		Toxics					X

WAPA

- NPS-WAPA has started a watershed-level project monitoring sedimentation on the near shore reefs. The marine monitoring portion currently includes water temperature and photosynthetically active radiation (PAR), and will soon add coral recruitment, and percent cover analysis.
- Guam Environmental Protection Agency (GEPA) (http://www.guamepa.govguam.net/programs/index.html) monitors recreational beach waters weekly for enterococci. Three sample locations are adjacent to WAPA units. One site is just north of the Asan Unit and the other two are to the North and South of the Agat Unit boundaries. GEPA is in the planning stages of a marine monitoring program that will be using EMAP, also still in the design process.
- The area south of Orote Peninsula is monitored by the US Navy as part of remediation for the Orote dump. This monitoring program includes analysis of water, invertebrates and fish for PCBs, heavy metals, dioxins, ferro-cyanins, and chlorinated pesticides. The area is currently open to recreational swimming but closed for fishing.
- The University of Guam, Water and Energy Resources Institute (WERI) (http://www.uog.edu/weri) conducts research projects on surface and groundwater quality, pesticide and heavy metal contamination, and soil run-off. They also analyze duplicate samples from the Navy's remediation program for the Orote Peninsula.

AMME

- The Division of Environmental Quality (DEQ) (http://www.deq.gov.mp/) regulates water quality and contaminants and is the permitting agency for pollution control, sewage disposal and earth-moving activities. It monitors water quality and administers most of the federal clean water laws. They conduct weekly monitoring of enterococci, fecal coliform, and nutrients near the Hyatt sewage outfall into the ocean adjacent to the park. They also monitor runoff at a site adjacent to the park boundary and at a storm water discharge basin created to prevent pollution runoff into the area near Smiling Cove Marina.
- The University of Guam, Water and Energy Resources Institute (WERI) (http://www.uog.edu/weri) conducts research projects on surface and groundwater quality, pesticide and heavy metal contamination, and soil run-off. WERI is involved with some water quality work in the Puerto Rico Mud Flats, located NE of the park, which is the site of a military dump that has recently been closed. This area could qualify as a superfund site.
- Coastal Resource Management is involved with benthic studies.
- A hydrological study of the AMME wetland has been funded by the USGS-WRD for FY05. This wetland has fresh water at the periphery and is saline in the center indicating some connection to the ocean. Still in the planning stages, USGS will be doing this work and may monitor the groundwater level and salinity.

NPSA

- The American Samoa Environmental Protection Agency (ASEPA) is currently monitoring streams in the territory based on a probabilistic design within a human impact framework. One of their pristine sites is located in NPSA (Fagatuitui). This stream is sampled monthly for temperature, dissolved oxygen, pH, sp conductivity, nutrients, bacteria and flow. Sampling started in April, 2003 and will continue for 1 year. At that time another round of streams will be chosen randomly which may include another site in NPSA.
- The World Wildlife Fund (WWF) has received a grant through the Environmental Protection Agency to do climate change research in the territory. Two of their seven sites are located in NPSA (Vatia and Tafeu Cove). As part of the project, paired water quality samples are taken from the stream and coral reef. Parameters include: nutrients, Chl a, DOC, and CDOM. Sampling started in October, 2002 and will continue quarterly until June, 2004.
- NPSA currently has long-term temperature loggers on the reef in Vatia and Ofu.

USAR

- USGSs Curt Storlazzi, NPS-USARs Marshall Owens, and the Submerged Resources Centers Matt Russell deploy and recover two instruments to measure the physical and chemical environment around the USS Arizona Memorial. Beginning in November 2002, A Sontek Triton wave/tide gauge has been measuring the physical environment: current velocity and direction, tidal and wave action, including surface wind waves. Water temperature, salinity, pH, dissolved oxygen, and oxidation-reduction potential are monitored using a YSI 6600 Sonde multisensor. These instruments must be recovered to download monitoring data approximately every two months. The program is anticipated to end after 12 to 15 months of data collection.
- The US Navy has several monitoring programs for its various industrial activities in Pearl Harbor. The analytical work is performed by the Navy Public Works Center Environmental Laboratory located in the Pearl Harbor Naval Complex. The outfall from Fort Kamehameha Wastewater Treatment Facility discharges near the mouth of Pearl Harbor and its mixing zone is monitored quarterly for temperature, ammonia, nitrate/nitrite, total nitrogen, total phosphorous, turbidity, chlorophyll a, salinity, dissolved oxygen, and pH. The effluent is monitored continuously for total residual chlorine, and daily determinations are made for 5-day BOD, total suspended solids, pH, settleable solids, and oil and grease. Monthly analyses are performed to monitor effluent levels of ammonia, nitrate/nitrite, total nitrogen, total phosphorous, 5-day BOD and total suspended solids percent removal, the heavy metals; cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc, and toxicity testing with *C. dubia* and *T. gratilla*.
- After qualifying rainfall events, storm water runoff is monitored at eight industrial sites in and around the Pearl Harbor Naval Compound. Depending on the industrial activities in the drainage area being sampled, analytes may include aluminum, arsenic, cadmium, chromium, copper, total cyanide, iron, lead, magnesium, mercury, nickel, selenium, silver, titanium, zinc, MBAS, chemical oxygen demand, biological oxygen, demand total suspended solids, total dissolved solids, ammonia, nitrate/nitrite, total nitrogen, total kjeldahl nitrogen, total phosphorous, pH, specific conductance, oil and grease, total petroleum hydrocarbons (THP), THP as gasoline, THP as diesel, total fuel hydrocarbons, and 21 organic compounds.

KALA

- No water quality monitoring is being done in this park at this time.
- The framework for a cooperative monitoring system on an island level is in place through work with the federal Enterprise Community (EC) designation and implementation, and USDA NRCS Watershed Restoration Action Strategy for the south shore of Molokai.

HALE

- USGS Water Resources has a stream gauge inside the park at Kipahulu monitoring its flow only.
- No other water quality monitoring is being done in this park at this time.

ALKA

- Mauna Kea Soil and Water Conservation District (MKSWD) is a watershed partnership that is monitoring stream dynamics and erosion upslope from the park. They have instigated changes in land use aimed at decreasing the impact of the cattle ranch, stream diversion and recent drought. Management partnerships have been developed with cattle ranches that include vegetative growth studies and water storage and distribution strategies that will aid in fire suppression. Other projects include precipitation, sediment and vegetative cover monitoring by University of Hawaii, Hilo staff and students. New rain gauges and check dams are being installed to monitor the watershed, and an automatic sampling device is ready to be implemented under a bridge over Makeahua Stream pending final approval from Hawaii State Department of Transportation. This device will automatically measure and store data on flow rate and turbidity upon flood events and at regular intervals when the stream is running. Another automatic sampler is planned for Makahuna Stream. MKSWD is actively involved in developing a useful monitoring plan for the marine area of Pelekane Bay.
- Hawaii State Department of Health (DOH) monitors monthly for enterococci and C. perfringins using the membrane filtration method at Kawaihae Harbor, Spencer County Beach Park, Hapuna State Beach Park, two sites near Puako Bay, Anaehoomalo Bay, two sites at Honokohau Harbor, two sites in Kailua Bay, “Banyans” surf spot, Disappearing Sands County Beach Park, Kahaluu County Beach Park, and Keauhou

Bay. Portable meters are used at these collection sites to measure temperature, salinity, turbidity, dissolved oxygen, and percent dissolved oxygen. A one-time collection for water chemistry is planned for three sites in Pelekane Bay: one from the pond formed by the damming of Makeahua Stream, and two marine samples to the North and the South sides of the bay. Inorganic nutrients (nitrate/nitrite, ammonium, phosphate, and silicate), total nitrogen, total phosphorous, temperature, pH, salinity, dissolved oxygen, turbidity, and total suspended solids will be determined for these locations.

- Biweekly bacteria testing is being conducted by AECOS lab at a man-made recreational pond inside a resort at Kaupulehu.
- Natural Energy Laboratory of Hawaii Authority (NELHA) has an on-going water quality monitoring program at Keahole Point that was begun in 1982. Twenty-one groundwater monitoring wells are sampled monthly for temperature, pH, salinity, dissolved oxygen, fecal coliform, enterococci, total phosphorous, total nitrogen, and the inorganic nutrients; nitrate/nitrite, phosphate, ammonium, and silicate. Two anchialine ponds, two aquaculture outfalls, seven coastal locations and six offshore transects, surface and bottom, are monitored quarterly for the same parameters as the wells listed above with the addition of chlorophyll a and turbidity measurements.
- Bacterial monitoring is also conducted on a saltwater swimming pool inside the Royal Sea Cliff Condominiums south of Kailua by AECOS.
- The National Parks Service Inventory and Monitoring Program has initiated monitoring of the anchialine ponds which includes water quality.

PUHE

- Mauna Kea Soil and Water Conservation District (MKSWD) is a watershed partnership that is monitoring stream dynamics and erosion upslope from the park. They have instigated changes in land use aimed at decreasing the impact of the cattle ranch, stream diversion and recent drought. Management partnerships have been developed with cattle ranches that include vegetative growth studies and water storage and distribution strategies that will aid in fire suppression. Other projects include precipitation, sediment and vegetative cover monitoring by University of Hawaii, Hilo staff and students. New rain gauges and check dams are being installed to monitor the watershed, and an automatic sampling device is ready to be implemented under a bridge over Makeahua Stream pending final approval from Hawaii State Department of Transportation. This device will automatically measure and store data on flow rate and turbidity upon flood events and at regular intervals when the stream is running. Another automatic sampler is planned for Makahuna Stream. MKSWD is actively involved in developing a useful monitoring plan for the marine area of Pelekane Bay.
- Hawaii State Department of Health (DOH) monitors monthly for enterococci and C. perfringins using the membrane filtration method at Kawaihae Harbor to the North and Spencer State Beach Park adjacent to the South boundary. Portable meters are used at these collection sites to measure temperature, salinity, turbidity, dissolved oxygen, and percent dissolved oxygen. A one-time collection for water chemistry is planned for three sites in Pelekane Bay: one from the pond formed by the damming of Makeahua Stream, and two marine samples to the North and the South sides of the bay. Inorganic nutrients (nitrate/nitrite, ammonium, phosphate, and silicate), total nitrogen, total phosphorous, temperature, pH, salinity, dissolved oxygen, turbidity, and total suspended solids will be determined for these locations.

KAHO

- A two-year project funded by NPS-WRD to monitor nutrient fluctuations in wells, anchialine pools, Kaloko Pond and Aimakapa Pond will be implemented in 2004(?). This project will perform dye tracer studies to determine the residence time of water in the pools and ponds and will collect samples to analyze for biologically available nitrogen and phosphorus in the groundwater. Salinity, dissolved oxygen, silica, chlorophyll a and other pigments will also be monitored.
- KAHO staff and community groups will be removing invasive algae from Kaloko Pond and monitoring for changes in benthic biota and substrate.
- The Natural Energy Laboratory of Hawaii Authority (NELHA) has an on-going water quality monitoring program at Keahole Point two miles North of Kaloko Pond that was begun in 1982. Twenty-one groundwater monitoring wells are sampled monthly for temperature, pH, salinity, dissolved oxygen, fecal coliform, enterococci, total phosphorous, total nitrogen, and the inorganic nutrients; nitrate/nitrite, phosphate, ammonium, and silicate. Two anchialine ponds, two aquaculture outfalls, seven coastal

locations and six offshore transects, surface and bottom, are monitored quarterly for the same parameters as the wells listed above with the addition of chlorophyll a and turbidity measurements.

- Hawaii State Department of Health (DOH) monitors monthly for enterococci and C. perfringins using the membrane filtration method at two Honokohau Harbor boat ramps directly adjacent to the park and two locations near the pier in Kailua Bay, a few miles to the South. Portable meters are used at these collection sites to measure temperature, salinity, turbidity, dissolved oxygen, and percent dissolved oxygen.

PUHO

- No water quality monitoring is being done in this park at this time.

HAVO

- David Foote (USGS) has a funded I&M project to survey selected invertebrates and water chemistry in some anchialine pools.
- The USGS has stream gauges and monitoring wells outside of park boundaries, but within the watershed. The parameters monitored in streams are temperature, flow, depth, turbidity, color, specific conductance, dissolved solids, dissolved oxygen, pH, carbon dioxide, alkalinity, bicarbonate, carbonate, nitrite/nitrate, ortho-phosphate, phosphorous, silicon, total hardness, dissolved minerals; calcium, magnesium, sodium, potassium, chloride, sulfate, and fluoride, and the metals; hexavalent chromium, cobalt, copper, iron, lead, manganese, nickel, strontium, zinc, aluminum, and lithium. Assays were performed to determine total coliform using membrane filtration.

Pacific Island Network Water Quality Monitoring Program Goals

Problem Statement/Values to Protect

In order to effectively address the issues of defining the values we want to protect and creating a problem statement, we first discussed what the purpose of our monitoring program is, and why we desire to monitor aquatic resources in the network. There were many purposes identified for a monitoring program in the Pacific Island Network (PACN) (Appendix A). Several of these are identical to those published for the National Inventory and Monitoring program (http://science.nature.nps.gov/im/monitor/vsmTG.htm#GoalsObj). Environmental attributes and values that the group felt was worth protecting was also a topic of discussion (Appendix B). These mainly focused on human and ecological health issues. Since there is a very strong cultural aspect to each park in the network, it was also widely felt that there should be consideration of cultural use of resources (past and present) in management decisions and development of guidelines and regulations.

The group came up with an extensive list of perceived/potential problems in network water resources (Appendix C). Priorities from this list are threats based and may be different for each park in the network. In addition to traditional sample parameters, some felt that non-traditional parameters would be worth preliminary sampling to then determine suitability (e.g. hydrocarbons, hormones, suntan lotion, caffeine, nicotine, estrogen, etc.).

It was decided that monitoring issues need to be identified at the park level. Many decisions will need to be made by the parks regarding desired monitoring. Considerations that were discussed include, general monitoring vs. issue focused impact monitoring, and process vs. time series monitoring. Regular availability of monitoring results will help to alleviate public concerns or misconceptions, and provide justification for management guidelines and regulations. Data will also support future guidelines. It was widely agreed upon that state and territory standards need to be reviewed, and the monitoring program should establish basic ecological goals for water quantity and quality beyond State human health parameters.

In order to accomplish all that the group felt was necessary, it was strongly suggested that water quality expertise be developed from within the network. Internally, we might develop a program with a strong park focus that would reflect and advocate decision making from an ecological perspective which would be preferable to continually funding consultant work. Potentially, this would also streamline the logistics of sampling effort, equipment maintenance, data management, etc. throughout the network.

Monitoring Objectives and Questions

Another workgroup focused on the issue of specific monitoring objectives and questions for the parks in the PACN. Broad objectives (Appendix D) and broad questions (Appendix E) were identified. It was recognized that monitoring suggestions and decisions will ultimately come from individual parks. At some level, data compatibility is important. Consideration for network-level vital signs, core parameters, and associated issues will need to reflect those at the park-specific level relating to park specific threats. Another consideration in setting up a monitoring program will be identifying and addressing current site specific threats and perceived threats. We certainly need to take advantage of the fact that water quality provides an opportunity for quantifiable measures of ecosystem health and conditions. We will need to work closely with both the freshwater biology and marine workgroups in order to prevent duplicate efforts. Multiple lines of evidence will also better support management claims (e.g. water column, sediments, tissue samples, bio-indicators).

When considering the overall water quality monitoring program for the network, it was suggested that we use three categories for classifying waters: ground water, surface water, and marine. Monitoring considerations for various water bodies were also discussed at some length. Although groundwater is typically handled through the geology workgroup nationwide, the obvious link in the islands between ground and surface water resources cannot be ignored (e.g. anchialine pond concerns focus on nutrients, oxygen, salinity, and ground water quantity inputs). Because of this, we will concern ourselves with groundwater quality and quantity where appropriate. Typically, core parameters for surface and marine waters are the same. Field and laboratory methods and details of application are often different, although driving stressors which provide reason for monitoring are often the same. Increasingly, enclosed marine areas are often more similar to fresh water habitats. Biocriteria in some geographic locations exist for small streams, large rivers, wetlands, and lakes. Marine and estuarine biocriteria are typically not well developed. Needs for ‘regular’ water quality parameters vs. contaminants differ and each need to be considered. Lipid bags have been tested with success at Kaloko-Honokohau National Historical Park. In marine and well environments, lipid bags provide longer residual contact time than other water sample methods for detecting low concentration pollutants.

Desired Future Conditions

In order to design a monitoring program that will inform management decisions, we first need to know what conditions we are striving to achieve. Group discussions defined what success in water resource stewardship should look like for the PACN (Appendix F), and what the natural conditions and processes are that should be preserved for future generations (Appendix G).

In developing a monitoring program, it is also critical to define what will be used as a baseline for comparison. There are various ideas for possible baselines that have been used by other programs through time. For example, some programs decide they want conditions to return to those of pre-industrial times, some use reliable memories of what conditions used to be, and still others rely on expert judgment. The group agreed that although we need a sense of long and short-term history of our park areas for decision making purposes, in the face of global climate change and increasing population and development, the PACN should use currently less impacted areas as a baseline. An appropriate ‘best condition’ site should be island-specific (e.g. Kipahulu Valley, Maui was mentioned for a potential site for Haleakala National Park, or upslope controls for streams). Different habitats (e.g. coral reef vs. seagrass) and water bodies (e.g. streams, anchialine ponds, marine) may use different criteria for baselines, and may require different standards. Regardless of which best condition sites are chosen for each park, it was decided that the network should, at a bare minimum, start by keeping conditions at least as good as they are presently and not allow further degradation.

There were several other points of discussion brought up during this session that are critical to keep in mind during the vital signs and monitoring development process. As we proceed, our conception of what is possible/attainable may change over time. The desired future conditions we have identified may not be attainable and/or may become more specific as we begin to obtain data from our monitoring efforts. It is also critical for park managers to make informed decisions and not manage blindly.

Conceptual Model

Review and Changes of Current Model

Changes were made to the conceptual model that was presented at the meeting to reflect comments and concerns of attendees. Primarily, the connections between drivers and stressors were made more clear while keeping the model broad enough for this stage of the process (Figure 1). The model is meant to encompass all water quality (fresh, marine, and ground water). Comments on this version of the model are welcome.

Preliminary Study Design

The US EPA's Environmental Monitoring and Assessment Program (EMAP) is a recommended program by WRD for marine water quality monitoring. A presentation about this design was given, and questions/comments were addressed. A copy of the presentation given by Kevin Summers is attached to this document (http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/kevin_epa-nca.pps).

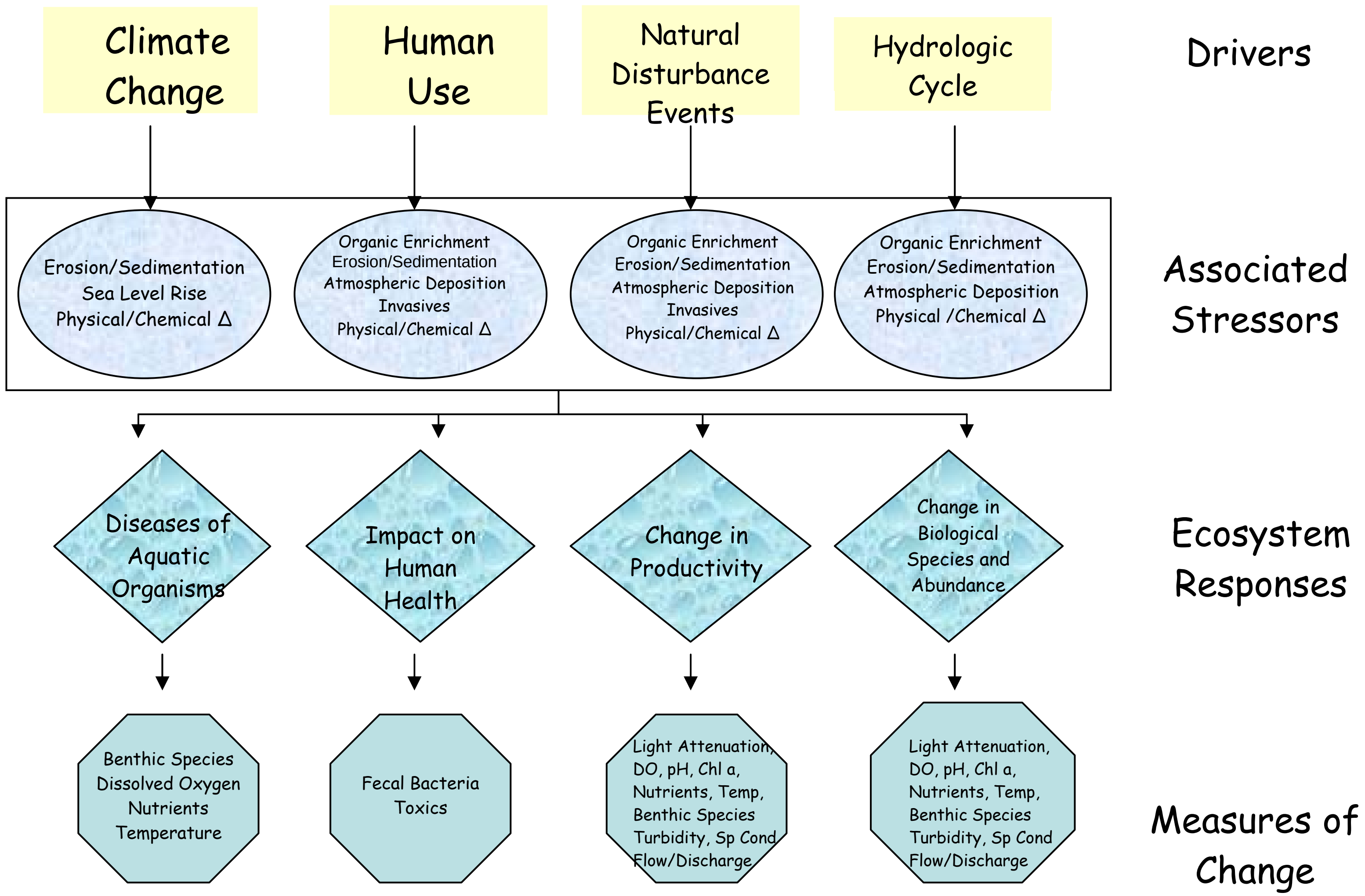
The EMAP design is a probabilistic one. It estimates the extent and condition of the resource, characterizes trends, and represents spatial patterns, all with known certainty. The design can allow statistical analysis at the park level, island level, state level, etc. depending on the monitoring question. It is important to understand that the EMAP approach is not hypothesis testing (process issues or questions), but a population characterization whereby you embrace differences with the aim of trying to find patterns. Differences are needed in order to see the patterns. Numerous pointers to stressors can also be provided, though not sources. If there is an area of interest that is not included in the sampling scheme, additional sites can be added and compared with the distribution of the other aggregated sites. Additional suggested boundary information about the EMAP program areas of interest for Pacific Island Network National Parks can be found in the attached power point presentation (http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/kevin_boundaries.pps).

Program standardization is important when possible. Regional and/or national data roll up is pleasing to program managers. Generated estimates may be useful to a network or program manager who is asking regional questions rather then park specific questions. Political implications for rolling up data as resource allocation decisions likely will be on the network level in the NPS I&M program.

Surface and ground water monitoring issues have been identified on a park-by-park basis. Prioritization of issues will be done as part of the Vital Signs process. Once priorities are established, partners will be consulted in order to develop a study design to address the identified needs.

Figure 1. PACN Water Quality Conceptual Model

*Includes Marine, Surface, and Ground Water.



Water Quality Monitoring Boundaries

The topic of water quality monitoring boundaries was a primary topic of discussion on day two of the meeting. Several questions were addressed regarding NPS limitations to monitoring outside of park boundaries. It was agreed that for water quality monitoring it is appropriate to collect samples outside of park boundaries if the information is helpful in the management of park waters. Even in situations where a park does not extend beyond the high tide line it was agreed that the parks have a shared interest in the resource and should work together with the appropriate state or territory for both monitoring and management.

Guidelines for determining the water quality monitoring boundaries were discussed. A general approach was developed from the concept of water flow rate and direction impacting the distribution of potential pollutants.

Park Lands: Water resources in the Pacific Island Network (or PACN) are governed by layers of legislation concerning park boundaries, state boundaries, and private or territorial lands and waters. Consequently, park water resources are affected by activities and conditions in areas out of their jurisdiction. Streams which pass through a park may be altered upstream through diversion or use as an outfall for industrial waste. Offshore currents may bring pollutants from nearby industrialized areas into an embayment or onto a reef. Fire and flood may increase sediment loading through a surrounding watershed. This leads to the conclusion that monitoring the water quality of areas outside of the parks is imperative to the successful management of all resources inside the parks.

Watersheds: Due to the simple fact that water flows down hill, it was agreed that watersheds should be included in the monitoring plan. Streams originate inside or upslope of parks and are affected by both natural and anthropogenic events. Most PACN parks are located in areas with high precipitation and porous substrate contributing to pollutants leaching directly into coastal areas. Those with more arid or less porous conditions are vulnerable to catastrophic flood events which result in erosion and uncontrolled dispersion of urban wastes.

Nearshore: Many of the PACN parks are located next to population centers with poor or non-existent waste treatment facilities and various sources of industrial pollutants. Currents running parallel to the shoreline can carry pollutants from nearby human activities into parks or cause changes in beach areas managed by the park.

The generalities being agreed upon, the question at hand is how far upslope, up/down current and offshore should the boundaries be set for a useful and practical water quality monitoring program. Each park has unique resources and stressors which need to be taken into consideration. To address this diversity, dedicated resource staff from each park described outstanding resources and environmental stressors relating to the water quality in their area and recommended monitoring boundaries appropriate to their park. These ideas were discussed with park resource managers and other water quality experts and resulted in the following suggestions for water quality monitoring boundaries in the Pacific Network.

Marine Boundaries

> Several alternatives were suggested for establishing marine areas of interest. For offshore distances, arbitrary distances of ½ mile, or depth contours of 100’ or 120’ were most often suggested (at HALE, a 200’ contour was suggested; at PUHE 100’…). In all cases, the existing park boundary should be used if it extends farther than the chosen criteria. Offshore study areas should extend laterally along the coast from the authorized park boundary up to one half mile up current or to the next point which may create an embayment. In most shoreline parks, the current runs from east to west. They should also encompass any immediately adjacent embayment, up or down current

Land Boundaries

> Stream water and groundwater quality can be helpful for determining early warning signs of change. Water quality study areas should encompass the entire park land area and be inclusive of the adjacent watershed. They should extend from the park boundary upslope to the top of the watershed, and downslope approximately 1 mile. In some Western Pacific Islands, the whole island may be included as the monitoring area using this criteria. On the island of Hawaii, this may mean watersheds that are orders of magnitude larger than parks. After preparing draft samples of maps reflecting these boundaries for all parks, these definitions will be refined.

Revision Process: Using the strategy outlined above, proposed areas of interest for monitoring were drawn onto existing park maps. Some parks make up their own watershed and are quite expansive, while others are dwarfed by their surrounding watershed. In either case, the proposed area could cover most of the island. For this reason two types of maps were made. The marine boundary map shows the proposed shoreline boundary up and down current from the park borders along with both proposed offshore limits. Lines showing where 1/2 mile from the shoreline and the 120 foot depth contour are also shown. Another map depicts each park within its respective watershed. Proposed maps for each park can be found in Appendix H. The locations of USGS monitoring wells and stream gauges will be included in future monitoring area maps. These preliminary charts will be circulated back to the resource staff at each park and other qualified experts for comment. Final monitoring areas will be proposed after a thorough review and consultation process which includes the practicality of the scope of work involved.

Appendix A.
Purpose for Water Quality Monitoring in the Pacific Island Network

- Identify and characterize current conditions.
- Establish and track status and trends in Vital Signs.
- Identify stressors and potential causes to assist managers in designing management actions based on the best available, defensible scientific information.
- Provide early warning changes of water quality.
- Develop and feed models designed to predict changes related to known or potential threats.
- Establish a baseline.
- Determine the impacts of existing and past cultural and recreational uses on protected resources in parks.

Appendix B.
Environmental Attributes and Values to be Protected in the Pacific Island Network

- Healthy bathing and swimming waters.
- Ecological integrity and ecological health (e.g. healthy habitats and biotic assemblages).
- Aesthetics/viewscapes/odorscapes/soundscapes.
- Natural physical processes within the system.
- System fluctuations within natural ranges.
- Rare or endangered biota.

Appendix C.
Perceived and Potential Problems in Pacific Island Network Water Resources

- Global Change – increased dissolved CO_2, sea level and temperature rise with associated impacts to coral reefs (bleaching, disease).
- Ozone depletion and/or ozone concentration in urban areas with associated impacts from changes in light levels and other ambient conditions.
- Stream impacts: diversion, sedimentation, streambed erosion, pesticides, insecticides, herbicides, over-watering.
- Groundwater impacts.
- Loss of flow.
- Bio-accumulation - despite the common impression that water quality degradation is ameliorated by ocean currents/circulation, long term accumulation may be a significant issue.
- Non point source pollutants (e.g. agricultural fertilizer, pesticides, animal waste (including animal husbandry operations), herbicides, topsoil sedimentation,

automotive chemicals (hydrocarbons), coastal construction, road building, beach sand mining, wildfire, unpermitted land use actions, dumping (legal and illegal)).
- Shipping and navigational impacts (e.g. sedimentation, pollution, resuspension of sediments, grounding, exotic species).
- Urbanization.
- Recreational user impacts.
- Garbage dumps and associated leachates.
- Freshwater flow and water circulation in marine environments.
- Anthropogenic eutrophication.
- Pesticides, organic chemicals, heavy metals.
- Cruise ship impacts (e.g. harbor expansions, waste disposal including industrial chemicals associated with photo processing and dry cleaning).

Appendix D.
Broad Objectives for the Pacific Island Network Water Quality Monitoring Program

- Identify baseline conditions as evidence for change.
- Document status and trends.
- Identify information needed to manage resources including what are acceptable/unacceptable ranges, conditions, or thresholds.
- Communicate significance of degraded water quality using multiple lines of evidence.
- Suggest hints of causes of degradation or impairment (e.g. source and root cause, what focus should be to maximize efficiencies in use of limited resources).

Appendix E.
Questions to be Answered by the Pacific Island Network Water Quality Monitoring Program.

- Is a Vital Sign varying within normal, optimal ranges?
- What are normal, optimal ranges (especially in pristine areas)?
- Are there trends or changes in Vital Signs?
- What are present-day, baseline conditions for both core parameters as well as human health impacts?
- Are cycles (e.g. diurnal, seasonal, annual) evident?
- Are there regime shifts in natural systems?
- What Vital Signs meet neutral criteria?
- What are unacceptable ranges/conditions?

Appendix F.
What does Success in Water Resource Stewardship Look Like?

- An environment conducive to the survival and perpetuation of native biological communities.
- Sustainable resources varying up and down within natural/desirable ranges (given current climate).
- Non-impaired waters.
- Minimal human disturbances/influences which are superimposed on other stressors.
- Sustained management for human uses.
- Maintenance and/or restoration of natural processes or patterns.
- Consistent with the mission of NPS, resource protection goals, and enabling legislation for individual parks.
- Preserved water quality of nursery areas, many of which need to be identified.
- Diverse ecosystem with healthy populations.
- Recovery or restoration of degraded areas.
- Natural turbidity and nutrients.
- Monitoring relates back to management questions.
- Focused on water quality.

Appendix G.
Natural Conditions and Processes to Preserve for Future Generations

- Human land use not affecting sediment and nutrient dynamics.
- Larval dispersal
- Growth, reproduction.
- Biodiversity
- Water Quality
- Shoreline conditions and dynamics.
- Ecological health, condition, and function.
- Protection of rare or endangered biota.

Appendix H.
Park Maps: Proposed Area of Interest for Water Quality Monitoring

LARGE PDF FILES!

Guam

War In The Pacific National Historical Park, http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/map_wapa.pdf

Commonwealth of the Northern Mariana Islands

American Memorial Park, http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/map_amme.pdf

American Samoa

National Park of American Samoa, http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/map_npsa.pdf

Hawaii

U S S Arizona Memorial, http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/map_usar.pdf

Kalaupapa National Historical Park, http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/map_kala.pdf

Haleakala National Park, http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/map_hale.pdf

Ala Kahakai National Historic Trail (note: geographic selection of water quality data was determined to be inappropriate at the time of report preparation, water quality data needs will be addressed at a later date), http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/map_alka.pdf

Pu`ukohola Heiau National Historic Site, http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/map_puhe.pdf

Kaloko-Honokohau National Historical Park, http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/map_kaho.pdf

Pu`uhonua o Honaunau National Historical Park, http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/map_puho.pdf

Hawaii Volcanoes National Park, http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/2003-pre/waterq/map_havo.pdf